Siddharth **Mayya**

APPLIED SCIENTIST · *Robotics* · *Bio-Physics Inspired Robot Swarms* · *Resilient Robot Teams*

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Research Focus

Resilient Multi-Robot Teams	Leveraging heterogeneity for resilient multi-robot operations in real-world conditions
Task Allocation In Robot Teams	High-level behavioral/task planning & logistics for robot teams
Scalable Algorithms	Leveraing ideas from biology and physics for robust and scalable algorithm design

Summary

I specialize in leveraging interdisciplinary tools from robotics, control theory, biology, and physics to solve complex real-world engineering problems. In particular, I have focused on the design and development of robotics systems operating under severe sensory limitations or under environmental disturbances which affect their operations.

Education

Georgia Institute of Technology — *Atlanta, GA*

PhD in ELECTRICAL AND COMPUTER ENGINEERING — *August. 2016 - Dec. 2019*
- *Thesis: Local Encounters in Robot Swarms: from Localization to Density Regulation*
- Advisor: Magnus Egerstedt
- GPA: 4.0/4.0

Georgia Institute of Technology — *Atlanta, GA*

MASTERS IN ELECTRICAL AND COMPUTER ENGINEERING — *August. 2014 - May 2016*
- *Thesis: Safe open-loop strategies for handling intermittent communications in multi-robot systems*
- Advisor: Magnus Egerstedt
- GPA: 4.0/4.0

Manipal Institute of Technology — *Manipal, India*

B.E. IN ELECTRONICS AND COMMUNICATION ENGINEERING — *August. 2010 - June 2014*
- Received 100% scholarship on college tuition.
- GPA: 8.98/10.00

Professional Appointments

Amazon Robotics — *Boston, MA*

APPLIED SCIENTIST — *Dec. 2021 - Current*
- Designing task planning and task allocation algorithms for robotics systems operating in Amazon's facilities.

University of Pennsylvania — *Philadelphia, PA*

POST DOCTORAL RESEARCHER (GRASP LAB, ADVISOR: VIJAY KUMAR) — *Jan. 2020 - Nov. 2021*
- Designed hierarchical **optimization-based architectures** for multi-robot task planning, behavior planning, and decision making (using Drake/SNOPT/CVXPY/YALMIP)
- Sub-project leader (∼15 people) for multi-institute collaborative effort (`www.dcist.org`) developing a **ROS**-based dockerized environment for **full-stack robot swarm simulations** in **Unity**
- Designed multi-robot coordination algorithms under limited communications and sensing using **graph neural networks (GNNs)**
- Investigated **learning from demonstration** techniques for adaptive resource allocation in real-world conditions
- Closed-loop decentralized control of swarm of 500 vibro-actuated micro bristle-robots

Georgia Institute of Technology — *Atlanta, GA*

GRADUATE RESEARCH ASSISTANT (PhD, ADVISOR: MAGNUS EGERSTEDT) — *Aug. 2016 - Dec. 2019*
- Hands-on experience in swarm robot design & deployment:
  - **C/C++/Python** development on ESP8266/ ESP32/ Atmega328/ Raspberry Pi 4 processors with over-the-air updates
  - End-to-end development experience: from circuit design (**EAGLE**) to communication infrastructure (**ROS/ MQTT/Docker**) to robot tracking (**Vicon/ OpenCV**) to user API design (**Python/ MATLAB**) on the Robotarium (`robotarium.gatech.edu`)
  - Co-designed and developed a swarm of vibration-driven robots equipped with range sensors (`quixoticrobotics.org`)
- Successfully leveraged ideas from **active matter physics** for decentralized swarm control
- Developed an optimization framework for **minimum energy & resilient task allocation** in a team of robots with heterogeneous capabilities
- Developed & deployed algorithms which use inter-robot proximity encounters as an information source for achieving decentralized density regulation, **localization**, and **task allocation**

Tesla Motors — *Palo Alto, CA*

AUTOPILOT INTERN — *May 2015 - Aug. 2015*
- Conceptualized schemes to diagnose anomalous/potentially dangerous driving conditions and realized them in **C**
- Developed a Software-In-Loop simulator (**MATLAB/ Simulink**) to compute safety performance metrics using test-drive data
- Implemented a spline interpolation method to generate estimates of the road curvature based on intermittent trajectory and GPS data

Arizona State University
VISITING SCHOLAR WITH DR. STEPHEN PRATT, SCHOOL OF LIFE SCIENCES

Tempe, AZ
May 2018 - June 2018

- Investigated how *Temnothorax Rugatulus* ants utilize inter-ant encounters to **detect quorum**
- Conceptualized & performed **experiments** on *Temnothorax Rugatulus* ant colonies with the aim of achieving non-uniform ant densities within the nest
- Investigated the emergence of reverse tandem runs during disrupted emigrations of ant colonies.
- Used **OpenCV** to track the moving positions of ants within a colony via a camera

Georgia Institute of Technology
GRADUATE RESEARCH ASSISTANT (MASTERS)

Atlanta, GA
Aug. 2015 - May 2016

- Developed **reachability-based methods** for handling intermittent communications in multi-robot systems
- Developed an optimization based **power-saving hybrid control** strategy for multi-robot systems
- Design and development of the **GRITSBot**: an open-source robot for use on the Robotarium

Manipal Institute of Technology
TEAM LEAD, PARIKSHIT STUDENT SATELLITE TEAM

Manipal, India
March 2011 - Dec. 2013

- Designed and successfully tested a **three-axis PID control** system for stabilization of the satellite
- **Led a team of 7**, overseeing the design of attitude estimation algorithms, orbit determination algorithms, hardware design, and system integration
- Incorporated the attitude determination and control system algorithm into the real time operating system (RTOS) of the satellite. This included addressing various scheduling issues and developing firmware code
- Designed and developed a **satellite system simulator** in MATLAB featuring modules for control, attitude estimation, and orbital positioning. The whole system was later implemented in C

Freescale Semiconductors
ANALOG & MIXED SIGNAL INTERN

Noida, India
Jan. 2014 - July 2014

- Designed and implemented test cases to verify the functionalities of certain I/O Pads within a SoC
- Deployed **bash scripts** to automate execution of test cases involving a large number of files

Skills

Programming	**Python** (numpy, scipy, pandas, cvxpy, pydrake, pytorch), **C++** (STL, Eigen), **MATLAB**, Docker, Git, Bash, Micropython, Verilog
Hardware	Circuit Prototyping/manufacturing/SMD soldering, working with embedded devices, small motors
Languages	English, Hindi

Publications

Refereed Journal Publications

[1] Zhijian Hao, **Siddharth Mayya**, Gennaro Notomista, Seth Hutchinson, Magnus Egerstedt, and Azadeh Ansari. Controlling collision-induced aggregations in a swarm of micro bristle-robots. *Accepted. To Appear, IEEE Transactions on Robotics (T-RO)*, 2021.

[2] **Siddharth Mayya**, Ragesh Kumar Ramachandran, Lifeng Zhou, Vinay Kumar Senthil Kumar, Dinesh Thakur, Gaurav Sukhatme, and Vijay Kumar. Adaptive and risk-aware target tracking for robot teams with heterogeneous sensors. *IEEE Robotics and Automation Letters*, pages 1–1, 2022.

[3] **Siddharth Mayya**, Diego S. D'antonio, David Saldaña, and Vijay Kumar. Resilient task allocation in heterogeneous multi-robot systems. *IEEE Robotics and Automation Letters*, 6(2):1327–1334, 2021.

[4] Gennaro Notomista, Siddharth Mayya, Yousef Emam, Christopher Kroninger, Addison Bohannon, Seth Hutchinson, and Magnus Egerstedt. A resilient and energy-aware task allocation framework for heterogeneous multi-robot systems. *IEEE Transactions on Robotics*, pages 1–22, 2021.

[5] Sean Wilson, Paul Glotfelter, **Mayya, Siddharth**, Gennaro Notomista, Yousef Emam, Xiaoyi Cai, and Magnus Egerstedt. The robotarium: Automation of a remotely accessible, multi-robot testbed. *IEEE Robotics and Automation Letters*, 6(2):2922–2929, 2021.

[6] Sean Wilson, Paul Glotfelter, Li Wang, **Siddharth Mayya**, Gennaro Notomista, Mark Mote, and Magnus Egerstedt. The robotarium: Globally impactful opportunities, challenges, and lessons learned in remote-access, distributed control of multirobot systems. *IEEE Control Systems Magazine*, 40(1):26–44, 2020.

[7] María Santos, Gennaro Notomista, **Siddharth Mayya**, and Magnus Egerstedt. Interactive multi-robot painting through colored motion trails. *Frontiers in Robotics and AI*, 7:143, 2020.

[8] **Siddharth Mayya**, Sean Wilson, and Magnus Egerstedt. Closed-loop task allocation in robot swarms using inter-robot encounters. *Swarm Intelligence*, 13(2):115–143, 2019.

[9] **Siddharth Mayya**, Pietro Pierpaoli, Girish Nair, and Magnus Egerstedt. Localization in densely packed swarms using interrobot collisions as a sensing modality. *IEEE Transactions on Robotics*, 35(1):21–34, 2018.

Refereed Conference Publications

[10] Walker Gosrich, **Siddharth Mayya**, Rebecca Li, James Paulos, Mark Yim, Alejandro Ribeiro, and Vijay Kumar. Coverage control in multi-robot systems via graph neural networks. *Accepted. To Appear, IEEE International Conference on Robotics and Automation (ICRA), arXiv preprint arXiv:2109.15278*, 2022.

[11] Yousef Emam, **Siddharth Mayya**, Gennaro Notomista, Addison Bohannon, and Magnus Egerstedt. Adaptive task allocation for heterogeneous multi-robot teams with evolving and unknown robot capabilities. In *2020 IEEE International Conference on Robotics and Automation (ICRA)*, pages 7719–7725, 2020.

[12] Gennaro Notomista, **Siddharth Mayya**, Mario Selvaggio, María Santos, and Cristian Secchi. A set-theoretic approach to multi-task execution and prioritization. In *2020 IEEE International Conference on Robotics and Automation (ICRA)*, pages 9873–9879, 2020.

[13] **Siddharth Mayya**, Pietro Pierpaoli, and Magnus Egerstedt. Voluntary retreat for decentralized interference reduction in robot swarms. In *2019 International Conference on Robotics and Automation (ICRA)*, pages 9667–9673. IEEE, 2019.

[14] **Siddharth Mayya**, Gennaro Notomista, Dylan Shell, Seth Hutchinson, and Magnus Egerstedt. Non-uniform robot densities in vibration driven swarms using phase separation theory. In *2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pages 4106–4112, 2019.

[15] Gennaro Notomista, **Siddharth Mayya**, Anirban Mazumdar, Seth Hutchinson, and Magnus Egerstedt. A study of a class of vibration-driven robots: Modeling, analysis, control and design of the brushbot. In *2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pages 5101–5106. IEEE, 2019.

[16] María Santos, **Siddharth Mayya**, Gennaro Notomista, and Magnus Egerstedt. Decentralized minimum-energy coverage control for time-varying density functions. In *2019 International Symposium on Multi-Robot and Multi-Agent Systems (MRS)*, pages 155–161. IEEE, 2019. **Outstanding Paper Award Finalist**.

[17] Gennaro Notomista, **Siddharth Mayya**, Seth Hutchinson, and Magnus Egerstedt. An optimal task allocation strategy for heterogeneous multi-robot systems. In *2019 18th European Control Conference (ECC)*, pages 2071–2076. IEEE, 2019.

[18] **Siddharth Mayya**, Pietro Pierpaoli, Girish Nair, and Magnus Egerstedt. Collisions as information sources in densely packed multi-robot systems under mean-field approximations. In *Proceedings of Robotics: Science and Systems*, Cambridge, Massachusetts, July 2017.

[19] **Siddharth Mayya** and Magnus Egerstedt. Safe open-loop strategies for handling intermittent communications in multi-robot systems. In *2017 IEEE International Conference on Robotics and Automation (ICRA)*, pages 5818–5823. IEEE, 2017.

[20] Smit Kamal, Karun Potty, Chandrasekhar Nagarajan, **Siddharth Mayya**, and Adheesh Boratkar. Descent modeling and attitude control of a tethered nano-satellite. In *2014 IEEE Aerospace Conference*, pages 1–14. IEEE, 2014.

Thesis

[21] **Siddharth Mayya**. *Local Encounters in Robot Swarms: from Localization to Density Regulation*. PhD thesis, Georgia Institute of Technology, 2019.

[22] **Siddharth Mayya**. Safe open-loop strategies for handling intermittent communications in multi-robot systems. Master's thesis, Georgia Institute of Technology, 2016.

Honors & Achievements

2020	**Patent Pending on "The Brushbot: A Robust and Versatile Swarm Robotics Platform"**, Georgia Institute of Technology	*Atlanta, GA*
2020	**US Embassy Funded Project "What can robots teach us about the Covid-19 pandemic"**, 2020 Alumni Small Grants Program	*Rome, Italy*
2019	**Outstanding Paper Award Finalist**, International Symposium on Multi-robot and Multi-agent Systems	*Rutgers, NJ*
2018	**Among top 6 papers selected for Extended Publication in IEEE Transaction on Robotics**, Robotics: Science and Systems Conference	*Boston, MA*
2018	**Executive Vice President of Research Award for Best Poster**, Career, Research and Innovation Development Conference	*Atlanta, GA*
2010	**Full Tuition Fellowship Award**, Manipal Institute of Technology	*Manipal, India*

Service

International Contributions

1. **Lead Guest Editor for Springer Autonomous Robots (AURO) Journal Special Issue**
   - Special issue on "Robot Swarms in the Real World: from Design to Deployment"
2. **Lead Organizer for workshop at ICRA 2021:**
   - Titled "Robot Swarms in the Real World: From Design to Deployment"
   - hosted 200+ participants from 35 countries
   - brought together experts from industry and academia
   - fostered discussions on the challenges and opportunities in swarm robotics
   - organized corporate sponsorship to increase participant engagement
3. **Organizer of workshops, tutorials, and seminars:** Titled "What can robots teach us about the Covid-19 pandemic", these events are funded by the US Embassy in Rome via the 2020 Alumni Small Grants Program.
   - **delivered** a 4 week tutorial given to 100+ high school students
   - **simplified** complex interdisciplinary ideas on networked control and robotics
4. **As part of the Robotarium project**, I participated in robotics outreach programs for K-12 students from diverse backgrounds across the US.

Peer Reviewer

1. IEEE Transactions on Robotics (T-RO)
2. IEEE Transactions on Automatic Control (T-AC)
3. IEEE Transactions on Automation Science and Engineering (T-ASE)
4. IEEE Robotics and Automation Letters (RA-L)
5. Swarm Intelligence
6. Automatica
7. SAGE Adaptive Behavior
8. IEEE International Conference on Robotics and Automation (ICRA)
9. IEEE International Conference on Intelligent Robots and Systems (IROS)
10. IEEE Conference on Decision and Control (CDC)
11. IFAC World Congress

Presentations

Invited Talks

Strength in Numbers: Swarm Robotics and Its Applications   *Mumbai, India*
Bhabha Atomic Research Center   *Jul. 2017*
Future Technologies Talk

Local Interactions as Information Sources in Robot Swarms   *Atlanta, GA*
Georgia Institute of Technology   *Sept. 2018*
Robotics Student Seminar Series

Conference Talks and Presentations

Workshop on Cognitive and Social Aspects of Human Multi-Robot Interaction, IROS 2021   *Online Event*
Poster Presentation   *September 2021*
"Resilient Coalition Formation in Heterogeneous Teams via Imitation Learning"

International Conference on Robotics and Automation 2021   *Online Event*
Paper Presentation   *May 2021*
"Resilient Task Allocation in Heterogeneous Multi-Robot Systems"

Workshop on Heterogeneous Multi-Robot Task Allocation and Coordination, RSS 2020   *Online Event*
Spotlight Talk   *July 2020*
'A Resilient and Energy-Aware Task Allocation Framework for Heterogeneous Multi-Robot Systems"

Workshop on Resilient Robot Teams: Composing, Acting, and Learning, ICRA 2019   *Montreal, Canada*
Spotlight Talk and Poster Presentation   *May 2019*
"Optimal Task Allocation in Heterogeneous Multi-Robot Systems Using a Mixed Centralized/Decentralized Strategy"

International Conference on Robotics and Automation 2019   *Montreal, Canada*
Poster Presentation   *May 2019*
"Voluntary Retreat for Decentralized Interference Reduction in Robot Swarms"

International Conference on Robotics and Automation 2017   *Singapore*
Spotlight Talk and Poster Presentation   *May 2017*
"Safe open-loop strategies for handling intermittent communications in multi-robot systems"

Robotics: Science and Systems Conference 2017   *Boston, MA*
Spotlight Talk and Poster Presentation   *July 2017*
"Collisions as Information Sources in Densely Packed Multi-Robot Systems Under Mean-Field Approximations"

Workshop on Robust Autonomy in Heterogeneous Robot Teams, RSS 2017   *Boston, MA*
Poster Presentation   *July 2017*
"Robust Autonomy in Centralized Multi-Robot Systems"

Teaching Experience

Research Mentoring

As a part of the ECE 8803 Special Research Topics course (Fall 2017), I provided research guidance and mentoring to 4 students over the course of a semester. This involved weekly meetings to discuss progress in their research and point them towards relevant results in the literature.

As a postdoctoral researcher at the GRASP Lab, I have had the opportunity to work alongside and provide research mentorship to undegraduate and graduate students.

Teaching Assistant & Co-Instructor

Georgia Institute of Technology. ECE 6553: Optimal Control and Optimization (Spring 2017)

Media Coverage

1. "Tiny robots create art", *BBC*, October 16, 2020

2. "Robot swarms guided by human artists could paint colourful pictures", *The New Scientist*, October 14, 2020

3. "This Robot Lab Has No Idea What Its Robots Are Doing ", *The Wall Street Journal*, Aug 15,2017

4. "Ga. Tech Unveils World's First Open Robotics Research Lab", *National Public Radio*, Aug 24 2017

5. "'Robotarium' gives anyone access to robots", *BBC*, Aug 18 2017

References

1. Vijay Kumar, University of Pennsylvania
   Department of Mechanical Engineering and Applied Mechanics
   Mail: Department of Mechanical Engineering and Applied Mechanics, University of Pennsylvania, Philadelphia, PA, 19104-6315, USA
   Email: `kumar@seas.upenn.edu`, Phone: +1 215-898-3630

2. Magnus Egerstedt, University of California, Irvine
   Electrical Engineering and Computer Science
   Mail: Samueli School of Engineering University of California, Irvine, Irvine, CA 92697
   Email: `magnus@uci.edu`, Phone: +1 (949) 824-6002

3. Seth Hutchinson, Georgia Institute of Technology
   School of Interactive Computing
   Mail: College of Computing Building, Rm 216, 801 Atlantic Drive, Atlanta, GA 30332
   Email: `seth@gatech.edu`, Phone: +1 404-385-7583

4. Dylan Shell, Texas A&M University
   Department of Computer Science & Engineering
   Mail: TAMU 3112, College Station, TX 77843
   Email: `dshell@tamu.edu`, Phone: +1 979 845 2369

5. Alejandro Ribeiro, University of Pennsylvania
   Department of Electrical and Systems Engineering
   Mail: Room 411B, Warren Center for Data and Network Sciences, 3401 Walnut Street, Philadelphia, PA 19104
   Email: `aribeiro@seas.upenn.edu`, Phone: +1 612 889 9217